

**Preliminary studies on certain macroarthropod groups  
of a *Quercus coccifera* formation (Mediterranean-type ecosystem)  
with special reference to the diplopod *Glomeris balcanica***

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With 6 figures

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### 1. Introduction

Little information exists on the ecology of macroarthropods in Greece. Most studies are fragmentary, appearing as by-products of projects with other objectives (STAMOU *et al.*, 1984; SGARDELIS 1988). In 1984 a project concerning the activity and dynamics of the soil arthropods of a *Quercus coccifera* (L.) formation started. The present paper provides preliminary information on the composition and activity of the macrofauna (except insects) collected within the framework of the above mentioned project. The diplopod *Glomeris balcanica* (VERHOEFF), was found to dominate the litter and humus layers of the *Q. coccifera* shrubs. The existence of a single diplopod species in the study area, in numbers expected from the diplopod communities in the deciduous forests of Southern England (BLOWER, 1979), implies that *G. balcanica* plays an important role in litter fragmentation, activating the process of decomposition by the soil microorganisms (VAN DER DRIFT, 1951; WALLWORK, 1970). Thus special attention has been given to this species of diplopod.

### 2. The study area

The study area was a hill at the foot of Mt Hortiatiss at 400 m a.s.l., dominated by *Q. coccifera* shrubs, degraded mainly through overgrazing and urban activity. It should also be mentioned that the shrubs as well as the litter are heavily "contaminated" by dust coming from the nearby chalk pits (IATROU, in prep.).

The climate is considered to be a transition from mediterranean type to temperate (KARAGIANNAKIDOU-IATROPOULOU, 1983). During the sampling period the temperature fluctuated between  $-2.5$  and  $36^{\circ}\text{C}$  (fig. 1), while the water content of the organic layers varied between 7 % and 64 % (fig. 2).

### 3. Materials and methods

The sampling period extended from May 1984 to December 1986. During the period from May 1984 to July 1985 at each sampling occasion – at about 10 day intervals – 15 litter and humus sample units were taken by means of a metal cylinder 21 cm in diameter. From August 1985 and on, the number of sample units were reduced to 10, taken at monthly intervals. Details on the sampling design have been given elsewhere (IATROU, in prep.). The animals, extracted by the Berlese-Tullgren method were fixed in 70 % ethanol. They were counted and identified under a stereomicroscope. The extraction efficiency of the apparatus has been tested only for the life stages of *G. balcanica* and was estimated to be over 95 % (IATROU, in prep.).

### 4. Results

In table 1 census data regarding the 4 taxonomic groups recorded during the sampling period are presented. A total of 7,530 individuals were recorded, corresponding to a mean annual density of

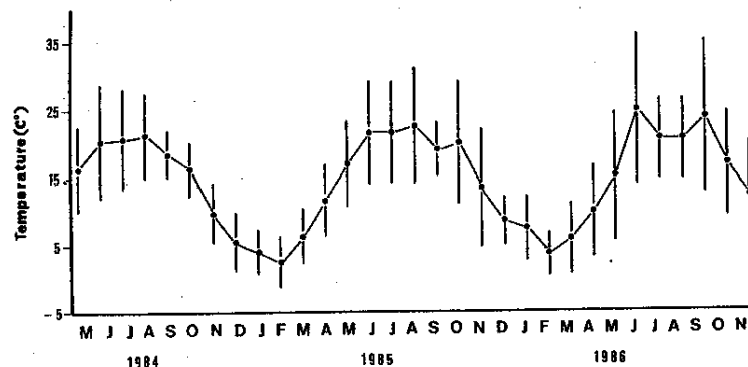


Fig. 1. Mean monthly temperature fluctuations in the experimental field during May 1984 – November 1986.

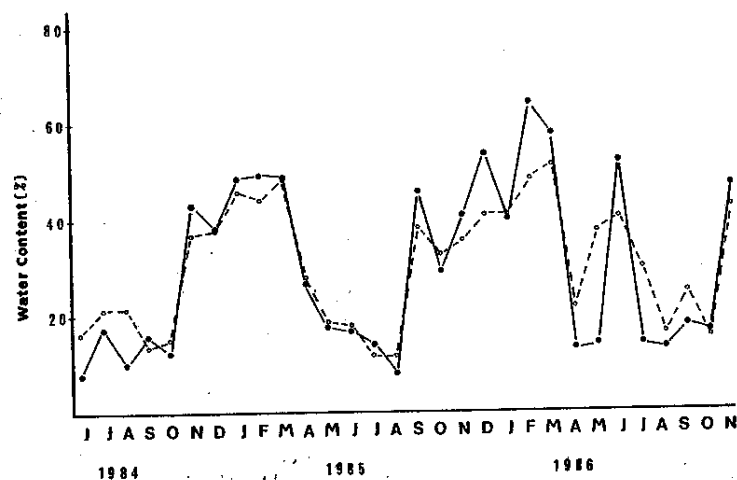


Fig. 2. Mean monthly water content of the *Q. coccifera* organic layers during May 1984 – November 1986. ----- Humus; — Litter.

315.76 ind  $\times$  m<sup>-2</sup>. The main bulk of the collected macrofauna consists of 2 taxonomic groups, namely Diplopoda and Araneae. Diplopods were the most numerous group of saprophages (Polyxenida as microphagous were excluded), with an overall mean density of 113.82 ind  $\times$  m<sup>-2</sup> forming 37.54% of the collected macrofauna; the contribution of Isopods is low (5.14%). Diplopoda are represented by two orders, Julida and Glomerida. It seems interesting that Julida represent only 5.05% of the collected macrofauna, while Glomerida represent 32.49%, having a single representative, namely *G. balcanica*.

Apart from Araneae the population densities of the other 3 taxonomic groups decrease during the second sampling period, and increase during the third one. In fig. 3 the seasonal density

Table 1. The number of collected specimens (N), % contribution (F) and mean annual population density (ind.  $\times$  m<sup>-2</sup>) of the taxonomic groups collected in the study area during 3 sampling periods A: May 1984–April 1985, B: May 1985–April 1986 and C: May 1986–December 1986.

Taxonomic group	N	F	Population density			
			A	B	C	$\bar{x}$
Diplopoda	2,827	37.54	120.44	64.16	156.86	113.82
Chilopoda	1,207	16.03	46.67	44.40	57.37	48.48
Isopoda	387	5.14	15.33	13.36	21.65	16.78
Araneae	3,109	41.29	106.71	137.73	165.60	136.68
Total	7,530	100	289.15	259.65	398.48	315.76

Note: Overall mean population density over the whole sampling period ( $\bar{x}$ ) is also given.

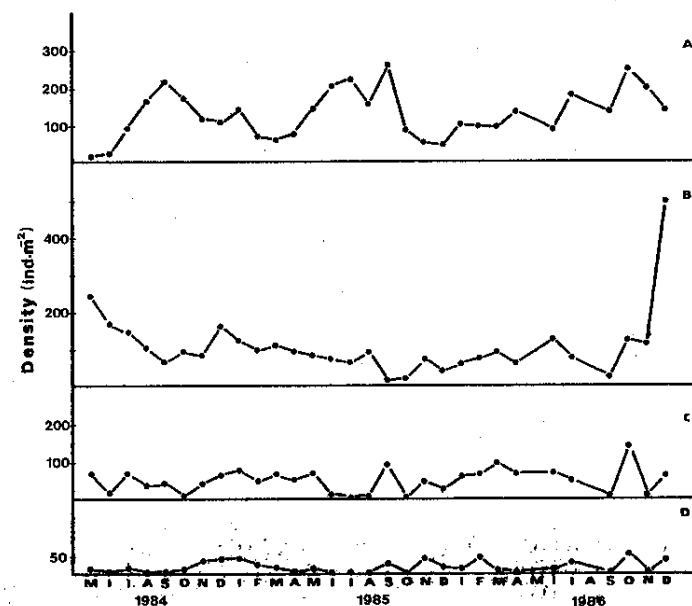


Fig. 3. Mean density fluctuations of four groups of macroarthropods collected during May 1984 – December 1986. A: Araneae, B: Diplopoda, C: Chilopoda and D: Isopoda.

variations of the collected macrofauna are shown. It should be mentioned that the efficiency of the Tullgren Funnel apparatus has only been checked in the case of *G. balcanica*, and consequently the population densities of the other three taxonomic groups should be considered cautiously. Araneae are characterized by a constant presence in the field exhibiting maximum population densities in the summer. The auto-correlation graph (fig. 4) showed that their population density exhibits a periodicity of about a year (peak at  $r_{11}$ ) while seasonality (peak at  $r_4$ ) was also detected. The mean annual density of Diplopoda shows a statistically highly significant decrease in the second sampling period (t-test). Diplopods appear to be most numerous in spring and autumn. Yet, no periodicity or

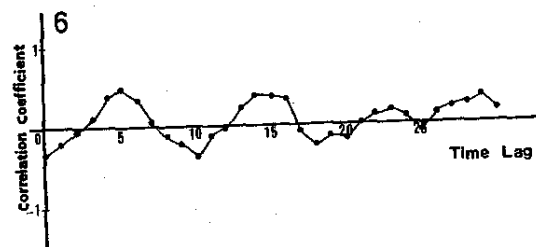
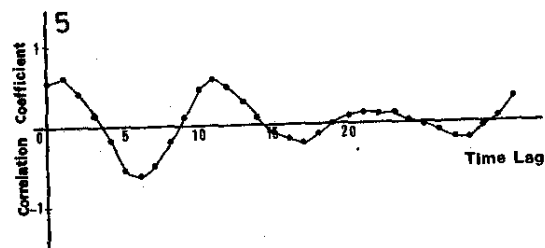
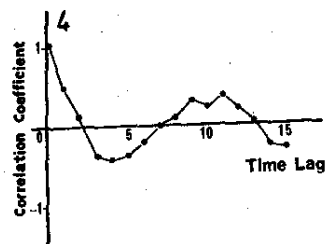


Fig. 4. Autocorrelation graph of the density fluctuations in Araneae.

Fig. 5. Cross-correlation graph between fluctuations in Araneae density and temperature.

Fig. 6. Cross-correlation graph between fluctuations in Araneae and Diplopoda density.

seasonality could be detected. The monthly variations in the density of Chilopoda are similar to those of Diplopoda, but the density maxima are not so pronounced. Finally, the population density of Isopoda exhibits maximum values during autumn and winter.

Cross-correlation graphs showed that population density variations in Araneae are more closely related to temperature than to the water content of the organic layers. As shown in fig. 5 temperature variations affect the density of Araneae with a delay of one month.

Although the population density fluctuations in Diplopoda seem to be non-periodic, yet a cross-correlation graph between them and Araneae (fig. 6) showed a negative inter-relationship with a time lag of 5 months.

## 5. Discussion

As far as the macrofauna (except insects) is concerned, the *Q. coccifera* soil subsystem is characterized by the presence of 2 taxonomic groups: a. Araneae, which are predators and constitute a very heterogeneous group with a wide range of environmental preferences (e.g. VAN DER DRIFT, 1951; KAJAK, 1960) and b. Diplopoda, *G. balcanica* being their main representative. This Diplopod seems to constitute the main agent of litter fragmentation in the study area.

The other groups are either sensitive to dehydration, such as Geophilomorpha (BLOWER, 1955), or they are not permanent inhabitants of the organic layers and are frequently located in areas between the *Q. coccifera* shrubs under stones (Lithobiomorpha, Isopoda), and so they are not recorded in high numbers.

As mentioned above, the densities of the two dominant groups were found to display a negative inter-relationship. An analogous phenomenon has also been recorded by LEVINGS & WINDSOR (1984). According to these authors, the inverse population density variation of Diplopoda and Araneae can be attributed to the changes of the water content of the organic layers to which Diplopoda exhibit a positive correlation, while Araneae exhibit a negative one.

According to VANNIER (1983) the resistance of a species to sudden changes of the environmental parameters shows either its capacity to colonize new areas or to survive an ecological disaster. It may also reflect a primordial adaptation embodied in the genetic code. From this point of view glomerids seem to be interesting. Glomerida are generally presented as typical colonizers of woods, and very often as dominant species in mature oak-forests (SCHUBART, 1934; BLOWER, 1955). Yet, species of this genus dominate extreme environments (HAACKER, 1968; STAMOU *et al.*, 1984; READ & MARTIN, 1988). Besides, BROCKSIEPER (1976) reports that *Glomeris* can be found in either very dry or very wet environments as well as in the litter layers of woods with low specific diversity. Indeed, glomerids seem to constitute a particular type of diplopod due to their conglobation. According to HAACKER (1968) they exhibit evolutionary convergence with Armadillidiidae, a family of isopods inhabiting xeric environments (SUTTON, 1972; KÜHNELT, 1976). Besides, laboratory experiments (THIELE, 1959; HAACKER, 1968) showed that glomerids prefer high as well as low relative humidities, have a temperature tolerance range between  $-6^{\circ}\text{C}$  and  $42^{\circ}\text{C}$ , and a temperature preference range between 18 and  $26^{\circ}\text{C}$ , although the reason of their euryokly remains ambiguous (DUNGER & STEINMETZGER, 1981).

The study site belongs to a wider area on which the human impact is very intensive mainly through overgrazing and industrial activity. It seems possible that degraded environments, caused either by human intervention or by natural disasters, may favour the presence of Diplopods, which are characterized by a huge development potential (TRACZ, 1984). Indeed, in our case *G. balcanica* dominates an area with extreme environmental conditions i.e. wide range of temperature and humidity fluctuations and human impact. Our point is that *G. balcanica*, despite its wide range of tolerance, lacking competitive advantage, can only prevail in areas where other species cannot survive.

## 6. Acknowledgements

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*Synopsis: Original scientific paper*

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Certain macroarthropod groups (insects not included) of a *Quercus coccifera* formation (Mediterranean-type ecosystem) were studied. The main bulk of the collected macrofauna consist of 2 taxonomic groups, Araneae (41.29 % contribution) and Diplopoda (37.53 % contribution). Density variations in Araneae are temperature related and exhibit annual periodicity, in contrast to those of Diplopoda where no yearly periodicity could be detected. Yet, the courses of density variation of these 2 groups were negatively inter-related with a time lag of 5 months. *Glomeris balcanica* was found to be the most abundant saprophagous macroarthropod. An attempt to relate its dominance with the extreme environmental conditions of the area was made.

**Key words:** Mediterranean-type ecosystem, macroarthropods, population density, variation

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